Using Simple Number Theory to Predict Stable Isotopes

Sean C. Williams
Herebe Ltd, Birkenhead, Wirral, UK
E-mail: isotope@herebe.co.uk

Abstract

An abstract method is described for predicting stable isotopes using simple number theory based on a system of predefined combinations, or "Blocks", of protons and neutrons. Each Block is made up of a prime number of protons, and a binary power increase in the number of neutrons. Predictions using the Block system fully includes all the stable isotopes.

Introduction

The fundamental nature of matter has been at the forefront of scientific consideration from ancient time's right up until the present day [1]. A semi-empirical formula for binding energy using a summation of volume, surface, Coulomb repulsion and symmetry is taught to undergraduates in the Liquid Drop Model. This model "does not account for some of the finer details of nuclear process however, such as stability" [2, see p. 1448]. The Shell Model goes a long way towards describing stability, but as with the Liquid Drop Model, this is a literal interpretation of the atomic nucleus requiring the Coulomb force [2, see p. 1451].

Al Rabeh has published work on the relationship between prime numbers, geometry and physical structure [3] and this gives a clear insight in to the relationship between a solution based on abstract number theory and empirical evidence. This paper discusses the use of a purely abstract method for predicting stable isotopes using number theory.

In this paper, an isotope is only considered stable if it does not have a reported half life; so by this definition, Technetium, Promethium and Tungsten are not considered to have any stable isotopes [4].

Selection of number series

The series of stable isotopes can be predicted using a simple number theory based on a system of

predefined combinations, or Blocks, of protons and neutrons. Each Block is made up a prime number of protons, and a binary power increase in the number of neutrons. When researching this subject, several combinations of number series were considered, including simple multiplication, logarithmic powers, the Fibonacci series and the Magic Number series. A method for substituting prime numbers and binary powers by a combination of averaged Fibonacci series has also been considered.

It may well turn out that the use of alternative number series could give a better match for stable nuclei, however, the system of prime numbers and binary powers described in this paper reveals a regular pattern of instability in isotopes that are constructed using Block A — this has not been found when using other number series.

Application of the number series

Since all stable isotopes, with the exception of Hydrogen and Helium, contain an equal or greater number of neutrons than protons, the Blocks have been designed with positive integers. This means that, by design, the system cannot construct an isotope model with fewer neutrons than protons, although in reality these clearly exist. A model for all stable isotopes can be constructed from the following combination of protons and neutrons — referred to here as Blocks: The proton count increases by prime numbers and the neutron count increases by powers of two (binary powers).

Table 1: Block system using prime and binary power number series

Block	P	N
A	1	1
B	2	2
C	3	4
D	5	8
E	7	16
F	11	32
etc		

Each isotope can be constructed using one or more of Blocks A, B, C, D, E, F, etc.; the only rule is that the largest Block available must be used. So, for example: Lithium-6 is created by combining one Block A (one proton and one neutron) and one Block B (two protons and two neutrons) = three protons and three neutrons. While Lithium-7 is created using a single Block C (three protons and four neutrons). Similarly, Neon-20 can be created using five units of Block B, whereas Neon-21 is created using three units of Block B and one of Block C. See Table 2: Applying the block system to isotopes:

Table 2: The combinations of blocks required to create isotopes between Lithium and Calcium.

Isotope	Stability	Z	N	Block A	Block B	Block C	Block D	Block E	Block F
6Li	STABLE	3	3	1	1				
7Li	STABLE	3	4			1			
8Be	6.7 E-17 s	4	4		2				
9Be	STABLE	4	5	1		1			
10B	STABLE	5	5	1	2				
11B	STABLE	5	6		1	1			
13B	17.3 ms	5	8				1		
12C	STABLE	6	6		3				
13C	STABLE	6	7	1	1	1			
14C	5.7 E+3 years	6	8			2			
14N	STABLE	7	7	1	3				
15N	STABLE	7	8		2	1			
16N	7.1 s	7	9	1		2			
17N	4.1 s	7	10		1		1		
16O	STABLE	8	8		4				
17O	STABLE	8	9	1	2	1			
18O	STABLE	8	10		1	2			
19O	26.4 s	8	11	1	1		1		
20O	13.5 s	8	12				1	1	
18F	109.7 min	9	9	1	4				
19F	STABLE	9	10			3	1		
20F	11.1 s	9	11		1	1	2		
21F	4.1 s	9	12			2		1	
22F	4.2 s	9	13	1		1	1		
20Ne	STABLE	10	10		5				
21Ne	STABLE	10	11	1	3	1			
22Ne	STABLE	10	12		2	2			
23Ne	37.2 s	10	13	1	2		1		
24Ne	3.3 min	10	14		1	1	1		
22Na	2.6 yr	11	11	1	5				
23Na	STABLE	11	12		4	1			
24Na	14.9 h	11	13	1	2	2			
25Na	59.1 s	11	14		3		1		
26Na	1.0 s	11	15	1	1	1	1		
27Na	301 ms	11	16			2	1		
28Na	30.5 ms	11	17	1			2		
24Mg	STABLE	12	12						
25Mg	STABLE	12	13		6				
26Mg	STABLE	12	14	1	4	1			
27Mg	9.4 min	12	15		3	2			
28Mg	20.9 h	12	16	1	3		1		
29Mg	1.3 s	12	17		2	1	1		
30Mg	335 ms	12	18	1		2	1		
33Mg	90.5 ms	12	21				2		
34Mg	20 ms	12	22		1	1		1	
36Mg	3.9 ms	12	24				1	1	
26Al	7.1 E+5 a	13	13	1	6				
27Al	STABLE	13	14		5	1			
28Al	2.2 min	13	15	1	3	2			
29Al	6.5 min	13	16		4		1		
30Al	3.6 s	13	17	1	2	1	1		
31Al	644 ms	13	18		1	2	1		
32Al	31.7 ms	13	19	1	1		2		
33Al	41.7 ms	13	20			1	2		
35Al	38.6 ms	13	22		3			1	
36Al	90 ms	13	23	1	1	1		1	
37Al	10.7 ms	13	24			2		1	
38Al	7.6 ms	13	25				1	1	
28Si	STABLE	14	14		7				
29Si	STABLE	14	15	1	5	1			
30Si	STABLE	14	16		4	2			
31Si	157.3 min	14	17	1	4		1		

32Si	132 a	14	18		3	1	1		
33Si	6.1 s	14	19	1	1	2	1		
34Si	2.7 s	14	20		2		2		
35Si	780 ms	14	21	1		1	2		
37Si	90 ms	14	23	1	3			1	
38Si	90 ms	14	24		2	1		1	
39Si	47.5 ms	14	25	1		2		1	
40Si	33.0 ms	14	26		1		1		
30P	2.4 min	15	15	1	7				
31P	STABLE	15	16		6	1			
32P	14.2 d	15	17	1	4	2			
33P	25.3 d	15	18		5		1		
34P	12.4 s	15	19	1	3	1	1		
35P	47.3 s	15	20		2	2	1		
36P	5.6 s	15	21	1	2		2		
37P	2.31 s	15	22		1	1	2		
39P	190 ms	15	24		4			1	
40P	153 ms	15	25	1	2	1		1	
41P	100 ms	15	26		1	2		1	
42P	48.5 ms	15	27	1	1		1	1	
43P	36.5 ms	15	28			1	1	1	
32S	STABLE	16	16		8				
33S	STABLE	16	17	1	6	1			
34S	STABLE	16	18		5	2			
35S	87.5 d	16	19	1	5		1		
36S	STABLE	16	20		4	1	1		
37S	5.0 min	16	21	1	2	2	1		
38S	170.3 min	16	22		3		2		
39S	11.5 s	16	23	1	1	1	2		
40S	8.8 s	16	24			2	2		
41S	1.9 s	16	25	1	4			1	
42S	1.0 s	16	26		3	1		1	
43S	260 ms	16	27	1	1	2		1	
44S	100 ms	16	28		2		1	1	
45S	68 ms	16	29	1		1	1	1	
34Cl	1.5 s	17	17	1	8				
35Cl	STABLE	17	18		7	1			
36Cl	3.0 E+5 a	17	19	1	5	2			
37Cl	STABLE	17	20		6		1		
38Cl	37.2 min	17	21	1	4	1	1		
39Cl	55.6 min	17	22		3	2	1		
40Cl	1.3 min	17	23	1	3		2		
41Cl	38.4 s	17	24		2	1	2		
42Cl	6.8 s	17	25	1		2	2		
43Cl	3.0 s	17	26		5			1	
44Cl	0.56 s	17	27	1	3	1		1	
45Cl	400 ms	17	28		2	2		1	
46Cl	232 ms	17	29	1	2		1	1	
47Cl	101 ms	17	30		1	1	1	1	
36Ar	STABLE	18	18		9				
37Ar	35.0 d	18	19	1	7	1			
38Ar	STABLE	18	20		6	2			
39Ar	269 a	18	21	1	6		1		
40Ar	STABLE	18	22		5	1	1		
41Ar	109.6 min	18	23	1	3	2	1		
42Ar	32.9 a	18	24		4		2		
43Ar	5.3 min	18	25	1	2	1	2		
44Ar	11.8 min	18	26		1	2	2		
45Ar	21.4 s	18	27	1	5			1	
46Ar	8.4 s	18	28		4	1		1	
47Ar	1.2 s	18	29	1	2	2		1	
48Ar	0.4 s	18	30		1	3		1	
49Ar	170 ms	18	31	1	1	1	1	1	
50Ar	85 ms	18	32			2	1	1	
51Ar	60 ms	18	33	1			2	1	
38K	7.6 min	19	19	1	9				
39K	STABLE	19	20		8	1			
40K	1.2 E+9 a	19	21		1	6	2		
41K	STABLE	19	22		7		1		

42K	12.3 h	19	23	1	5	1	1		
43K	22.3 h	19	24		4	2	1		
44K	22.1 min	19	25	1	4		2		
45K	17. 3min	19	26		3	1	2		
46K	105 s	19	27	1	1	2	2		
47K	17.5 s	19	28		6			1	
48K	6.8 s	19	29	1	4	1		1	
49K	1.2 s	19	30		3	2		1	
50K	472 ms	19	31	1	3		1	1	
51K	365 ms	19	32			1	1	1	
52K	105 ms	19	33	1		2	1	1	
53K	30 ms	19	34		1		2	1	
40Ca	>5.9 E+21 a	20	20		10				
41Ca	1.0 E+5 a	20	21	1	8	1			
42Ca	STABLE	20	22		7	2			
43Ca	STABLE	20	23	1	7		1		
44Ca	STABLE	20	24		6	1	1		
45Ca	162.6 d	20	25	1	4	2	1		
46Ca	>100E+15 a	20	26		5		2		
47Ca	4.5 d	20	27	1	3	1	2		
48Ca	43 E+18 a	20	28		2	2	2		
49Ca	8.7 min	20	29	1	6			1	
50Ca	13.9 s	20	30		5	1		1	
51Ca	10.0 s	20	31	1	3	2		1	
52Ca	4.6 s	20	32		4		1	1	
53Ca	90 ms	20	33	1	2	1	1	1	
54Ca	50 ms	20	34		1	2	1	1	
55Ca	30 ms	20	35	1	1		2	1	
56Ca	10 ms	20	36			1	2	1	

Comments on Table 2:
Isotopes that cannot be calculated using the Block method have been omitted.

- Total Isotopes reported between Lithium and Calcium: 365 [4].
- Isotopes predicted as stable between Lithium and Calcium: 160.
- Actual stable Isotopes between Lithium and Calcium: 39.

This method produces a good percentage of stable isotopes up to Calcium, and it fares particularly well between Lithium and Neon. After Calcium, the number of models of isotopes that can be constructed using the proton/neutron Blocks expands, however so does the number of isotopes per element. The proton/neutron Block system still predicts the stable isotopes (it never misses a stable isotope) however, the number of unstable isotopes appearing within the models starts to increase and rapidly becomes greater than that of the stable isotopes.

Modifying the number series

It becomes clear that to predict the stable isotopes beyond Calcium, an additional factor, or modifier, must be used in number series for calculating the Blocks. The proton/neutron Blocks are not enough to discriminate between stable and un-stable isotopes, and so modifiers can be added as a triangulation device to further refine the predictions. These modifiers are built in to the Block system in exactly the same way as protons and neutrons. There are many different series that can be used here and as many modifiers can be added as desired (e.g. o setting a prime number sequence), however, a single modifier that works quite well up to Calcium is a simple Fibonacci series (dubbed

the “Abs” modifier) as in Table 3.

Table 3: Protons in prime numbers, neutrons in binary powers and Abs in Fibonacci series.

Block	P	N	Abs
A	1	1	1
B	2	2	1
C	3	4	2
D	5	8	3
E	7	16	5
F	11	32	8
etc			

When plugging these figures in to the Block system, the results in Table 4 can be observed.

Table 4: Block system result using Abs modifier.

Isotope	Stability	Z	N	Abs	Block A	Block B	Block C	Block D	Block E	Block F
6Li	STABLE	3	3	2	1	1				
7Li	STABLE	3	4	2			1			
8Be	6.7 E-17 s	4	4	2		2				
9Be	STABLE	4	5	3	1		1			
10B	STABLE	5	5	3	1	2				
11B	STABLE	5	6	3		1	1			
13B	17.3 ms	5	8	3				1		
12C	STABLE	6	6	3		3				
13C	STABLE	6	7	4	1	1	1			
14C	5.7 E+3 years	6	8	4			2			
14N	STABLE	7	7	4	1	3				
15N	STABLE	7	8	4		2	1			
16N	7.1 s	7	9	5	1		2			
17N	4.1 s	7	10	4		1		1		
16O	STABLE	8	8	4		4				
17O	STABLE	8	9	5	1	2	1			
18O	STABLE	8	10	5		1	2			
19O	26.4 s	8	11	5	1	1		1		
20O	13.5 s	8	12	5				1	1	
18F	109.7 min	9	9	5	1	4				
19F	STABLE	9	10	5			3	1		

20F	11.1 s	9	11	6		1	1	2		
21F	4.1 s	9	12	5			2		1	
22F	4.2 s	9	13	6	1		1	1		
20Ne	STABLE	10	10	5		5				
21Ne	STABLE	10	11	6	1	3	1			
22Ne	STABLE	10	12	6		2	2			
23Ne	37.2 s	10	13	6	1	2		1		
24Ne	3.3 min	10	14	6		1	1	1		
22Na	2.6 yr	11	11	6	1	5				
23Na	STABLE	11	12	6		4	1			
24Na	14.9 h	11	13	7	1	2	2			
25Na	59.1 s	11	14	6		3		1		
26Na	1.0 s	11	15	7	1	1	1	1		
27Na	301 ms	11	16	7			2	1		
28Na	30.5 ms	11	17	7	1			2		
24Mg	STABLE	12	12	6						
25Mg	STABLE	12	13	7		6				
26Mg	STABLE	12	14	7	1	4	1			
27Mg	9.4 min	12	15	7		3	2			
28Mg	20.9 h	12	16	7	1	3		1		
29Mg	1.3 s	12	17	8		2	1	1		
30Mg	335 ms	12	18	7	1		2	1		
33Mg	90.5 ms	12	21	8				2		
34Mg	20 ms	12	22	8		1	1		1	
36Mg	3.9 ms	12	24	8				1	1	
26Al	7.1 E+5 a	13	13	7	1	6				
27Al	STABLE	13	14	7		5	1			
28Al	2.2 min	13	15	8	1	3	2			
29Al	6.5 min	13	16	7		4		1		
30Al	3.6 s	13	17	8	1	2	1	1		
31Al	644 ms	13	18	8		1	2	1		
32Al	31.7 ms	13	19	8	1	1		2		
33Al	41.7 ms	13	20	8			1	2		
35Al	38.6 ms	13	22	8		3			1	
36Al	90 ms	13	23	9	1	1	1		1	
37Al	10.7 ms	13	24	9			2		1	
38Al	7.6 ms	13	25	9	1			1	1	
28Si	STABLE	14	14	7		7				
29Si	STABLE	14	15	8	1	5	1			
30Si	STABLE	14	16	8		4	2			
31Si	157.3 min	14	17	8	1	4		1		
32Si	132 a	14	18	8		3	1	1		
33Si	6.1 s	14	19	9	1	1	2	1		
34Si	2.7 s	14	20	8		2		2		
35Si	780 ms	14	21	9	1		1	2		
37Si	90 ms	14	23	9	1	3			1	
38Si	90 ms	14	24	9		2	1		1	
39Si	47.5 ms	14	25	10	1		2		1	

40Si	33.0 ms	14	26	9		1		1			
30P	2.4 min	15	15	8	1	7					
31P	STABLE	15	16	8		6	1				
32P	14.2 d	15	17	9	1	4	2				
33P	25.3 d	15	18	8		5		1			
34P	12.4 s	15	19	9	1	3	1	1			
35P	47.3 s	15	20	9		2	2	1			
36P	5.6 s	15	21	9	1	2		2			
37P	2.31 s	15	22	9		1	1	2			
39P	190 ms	15	24	9		4			1		
40P	153 ms	15	25	10	1	2	1		1		
41P	100 ms	15	26	10		1	2		1		
42P	48.5 ms	15	27	10	1	1		1	1		
43P	36.5 ms	15	28	10			1	1	1		
32S	STABLE	16	16	8		8					
33S	STABLE	16	17	9	1	6	1				
34S	STABLE	16	18	9		5	2				
35S	87.5 d	16	19	9	1	5		1			
36S	STABLE	16	20	9		4	1	1			
37S	5.0 min	16	21	10	1	2	2	1			
38S	170.3 min	16	22	9		3		2			
39S	11.5 s	16	23	10	1	1	1	2			
40S	8.8 s	16	24	10			2	2			
41S	1.9 s	16	25	10	1	4			1		
42S	1.0 s	16	26	10		3	1		1		
43S	260 ms	16	27	11	1	1	2		1		
44S	100 ms	16	28	10		2		1	1		
45S	68 ms	16	29	11	1		1	1	1		
34Cl	1.5 s	17	17	9	1	8					
35Cl	STABLE	17	18	9		7	1				
36Cl	3.0 E+5 a	17	19	10	1	5	2				
37Cl	STABLE	17	20	9		6		1			
38Cl	37.2 min	17	21	10	1	4	1	1			
39Cl	55.6 min	17	22	10		3	2	1			
40Cl	1.3 min	17	23	10	1	3		2			
41Cl	38.4 s	17	24	10		2	1	2			
42Cl	6.8 s	17	25	11	1		2	2			
43Cl	3.0 s	17	26	10		5			1		
44Cl	0.56 s	17	27	11	1	3	1		1		
45Cl	400 ms	17	28	11		2	2		1		
46Cl	232 ms	17	29	11	1	2		1	1		
47Cl	101 ms	17	30	11		1	1	1	1		
36Ar	STABLE	18	18	9		9					
37Ar	35.0 d	18	19	10	1	7	1				
38Ar	STABLE	18	20	10		6	2				
39Ar	269 a	18	21	10	1	6		1			
40Ar	STABLE	18	22	10		5	1	1			
41Ar	109.6 min	18	23	11	1	3	2	1			
42Ar	32.9 a	18	24	10		4		2			

43Ar	5.3 min	18	25	11	1	2	1	2		
44Ar	11.8 min	18	26	11		1	2	2		
45Ar	21.4 s	18	27	11	1	5			1	
46Ar	8.4 s	18	28	11		4	1		1	
47Ar	1.2 s	18	29	12	1	2	2		1	
48Ar	0.4 s	18	30	12		1	3		1	
49Ar	170 ms	18	31	12	1	1	1	1	1	
50Ar	85 ms	18	32	12			2	1	1	
51Ar	60 ms	18	33	12	1			2	1	
38K	7.6 min	19	19	10	1	9				
39K	STABLE	19	20	10		8	1			
40K	1.2 E+9 a	19	21	11		1	6	2		
41K	STABLE	19	22	10		7		1		
42K	12.3 h	19	23	11	1	5	1	1		
43K	22.3 h	19	24	11		4	2	1		
44K	22.1 min	19	25	11	1	4		2		
45K	17. 3min	19	26	11		3	1	2		
46K	105 s	19	27	12	1	1	2	2		
47K	17.5 s	19	28	11		6			1	
48K	6.8 s	19	29	12	1	4	1		1	
49K	1.2 s	19	30	12		3	2		1	
50K	472 ms	19	31	12	1	3		1	1	
51K	365 ms	19	32	12			1	1	1	
52K	105 ms	19	33	13	1		2	1	1	
53K	30 ms	19	34	12		1		2	1	
40Ca	>5.9 E+21 a	20	20	10		10				
41Ca	1.0 E+5 a	20	21	11	1	8	1			
42Ca	STABLE	20	22	11		7	2			
43Ca	STABLE	20	23	11	1	7		1		
44Ca	STABLE	20	24	11		6	1	1		
45Ca	162.6 d	20	25	12	1	4	2	1		
46Ca	>100E+15 a	20	26	11		5		2		
47Ca	4.5 d	20	27	12	1	3	1	2		
48Ca	43 E+18 a	20	28	12		2	2	2		
49Ca	8.7 min	20	29	12	1	6			1	
50Ca	13.9 s	20	30	12		5	1		1	
51Ca	10.0 s	20	31	13	1	3	2		1	
52Ca	4.6 s	20	32	12		4		1	1	
53Ca	90 ms	20	33	13	1	2	1	1	1	
54Ca	50 ms	20	34	13		1	2	1	1	
55Ca	30 ms	20	35	13	1	1		2	1	
56Ca	10 ms	20	36	13			1	2	1	

NB Isotopes that cannot be calculated using the Block method have been omitted.

What can be seen from Table 4 is that whilst the proton and neutron numbers increase in an orderly and predictable pattern, the Abs modifier does not. Removing isotopes so that the Abs modifier increases in an orderly and predictable fashion results in Table 5.

Table 5: Block system result using "orderly" Abs modifier.

Isotope	Stability	Z	N	Abs	Block A	Block B	Block C	Block D	Block E	Block F
6Li	STABLE	3	3	2	1	1				
7Li	STABLE	3	4	2			1			
8Be	6.7 E-17 s	4	4	2		2				
9Be	STABLE	4	5	3	1		1			
10B	STABLE	5	5	3	1	2				
11B	STABLE	5	6	3		1	1			
13B	17.3 ms	5	8	3				1		
12C	STABLE	6	6	3		3				
13C	STABLE	6	7	4	1	1	1			
14C	5.7 E+3 years	6	8	4			2			
14N	STABLE	7	7	4	1	3				
15N	STABLE	7	8	4		2	1			
17N	4.1 s	7	10	4		1		1		
16O	STABLE	8	8	4		4				
17O	STABLE	8	9	5	1	2	1			
18O	STABLE	8	10	5		1	2			
19O	26.4 s	8	11	5	1	1		1		
20O	13.5 s	8	12	5				1	1	
18F	109.7 min	9	9	5	1	4				
19F	STABLE	9	10	5			3	1		
21F	4.1 s	9	12	5			2		1	
20Ne	STABLE	10	10	5		5				
21Ne	STABLE	10	11	6	1	3	1			
22Ne	STABLE	10	12	6		2	2			
23Ne	37.2 s	10	13	6	1	2		1		
24Ne	3.3 min	10	14	6		1	1	1		
22Na	2.6 yr	11	11	6	1	5				
23Na	STABLE	11	12	6		4	1			
25Na	59.1 s	11	14	6		3		1		
24Mg	STABLE	12	12	6						
25Mg	STABLE	12	13	7		6				
26Mg	STABLE	12	14	7	1	4	1			
27Mg	9.4 min	12	15	7		3	2			
28Mg	20.9 h	12	16	7	1	3		1		
30Mg	335 ms	12	18	7	1		2	1		
26Al	7.1 E+5 a	13	13	7	1	6				
27Al	STABLE	13	14	7		5	1			
29Al	6.5 min	13	16	7		4		1		

28Si	STABLE	14	14	7		7					
29Si	STABLE	14	15	8	1	5	1				
30Si	STABLE	14	16	8		4	2				
31Si	157.3 min	14	17	8	1	4		1			
32Si	132 a	14	18	8		3	1	1			
34Si	2.7 s	14	20	8		2		2			
30P	2.4 min	15	15	8	1	7					
31P	STABLE	15	16	8		6	1				
33P	25.3 d	15	18	8		5		1			
32S	STABLE	16	16	8		8					
33S	STABLE	16	17	9	1	6	1				
34S	STABLE	16	18	9		5	2				
35S	87.5 d	16	19	9	1	5		1			
36S	STABLE	16	20	9		4	1	1			
38S	170.3 min	16	22	9		3		2			
34Cl	1.5 s	17	17	9	1	8					
35Cl	STABLE	17	18	9		7	1				
37Cl	STABLE	17	20	9		6		1			
36Ar	STABLE	18	18	9		9					
37Ar	35.0 d	18	19	10	1	7	1				
38Ar	STABLE	18	20	10		6	2				
39Ar	269 a	18	21	10	1	6		1			
40Ar	STABLE	18	22	10		5	1	1			
42Ar	32.9 a	18	24	10		4		2			
38K	7.6 min	19	19	10	1	9					
39K	STABLE	19	20	10		8	1				
41K	STABLE	19	22	10		7		1			
40Ca	>5.9 E+21 a	20	20	10		10					
41Ca	1.0 E+5 a	20	21	11	1	8	1				
42Ca	STABLE	20	22	11		7	2				
43Ca	STABLE	20	23	11	1	7		1			
44Ca	STABLE	20	24	11		6	1	1			
46Ca	>100E+15 a	20	26	11		5		2			

Comments to the Table 5:

- Total Isotopes reported between Lithium and Calcium: 365 [4].
- Isotopes predicted as stable using Abs modifier between Lithium and Calcium: 71.
- Actual stable Isotopes between Lithium and Calcium: 39.

An interesting observation here is that it is the odd Z numbered elements that lose more isotopes when adjusting for the Abs modifier results in this way. When the Block sys-tem is applied to all the elements between Oxygen and Lead, it is revealed that there are no stable odd Z numbered elements that are built using Block A. This means that we can discount any isotope with an odd

atomic number and we will find more stable isotopes in the elements with even atomic numbers which do not use Block A

Future work

The Block method has been used to predict the stability of isotopes up to Lead with similar results. Calculating the full periodic table, however, requires the use of further modifiers to cope with the range. It is hoped that further work will re-veal the closest match between predicted and observed stability. Close approximations can be made by replacing the prime and binary power number series with simple combinations of Fibonacci sequences.

An example for Tin is shown in Table 6. This uses a simple scoring mechanism of a summation of absolute values of the modifier scores to show approximate stability of each isotope. Tin is an interesting element because it contains a high proportion of stable isotopes. The values for the modifiers are calculated as the average score for all isotopes for a particular modifier using a specific number sequence. So in the example below, the proton sequence is prime numbers, the neutron sequence is binary powers, the Abs modifier sequence is 1, 2, 3, 5, 8, 13, 21 and the Hat modifier is 2, 3, 5, 8, 13, 21, 34.

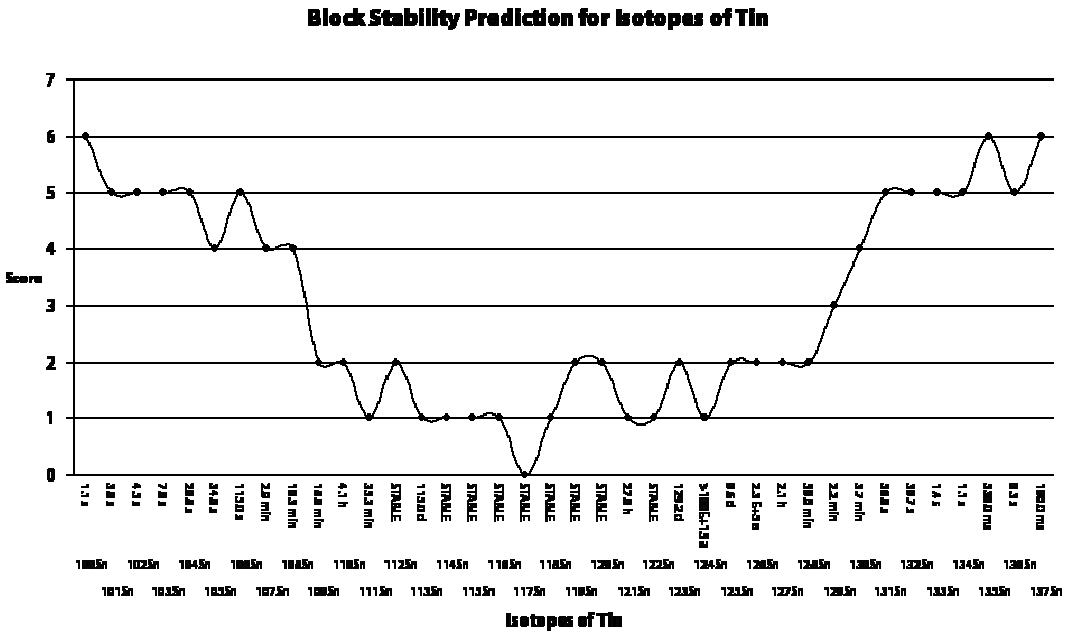
Table 6: An example for Tin using multiple modifiers (Abs and Hat) based on offset Fibonacci series.

Isotope	half-life	Z	N	abs	hat	Scores p	n	abs	hat	Score Total
100Sn	1.1 s	50	50	51	80	0	0	1	5	6
101Sn	3.0 s	50	51	51	80	0	0	1	4	5
102Sn	4.5 s	50	52	51	80	0	0	1	4	5
103Sn	7.0 s	50	53	51	80	0	0	1	4	5
104Sn	20.8 s	50	54	51	80	0	0	1	4	5
105Sn	34.0 s	50	55	51	80	0	0	1	3	4
106Sn	115.0 s	50	56	51	80	0	0	1	4	5
107Sn	2.9 min	50	57	51	80	0	0	1	3	4
108Sn	10.3 min	50	58	51	80	0	0	1	3	4
109Sn	18.0 min	50	59	51	80	0	0	0	2	2
110Sn	4.1 h	50	60	51	80	0	0	0	2	2
111Sn	35.3 min	50	61	51	80	0	0	0	1	1
112Sn	STABLE	50	62	51	80	0	0	0	2	2
113Sn	115.0 d	50	63	51	80	0	0	0	1	1
114Sn	STABLE	50	64	51	80	0	0	0	1	1
115Sn	STABLE	50	65	51	80	0	0	0	1	1
116Sn	STABLE	50	66	51	80	0	0	0	1	1
117Sn	STABLE	50	67	51	80	0	0	0	0	0
118Sn	STABLE	50	68	51	80	0	0	•1	0	1
119Sn	STABLE	50	69	51	80	0	0	•1	•1	2
120Sn	STABLE	50	70	51	80	0	0	•1	•1	2
121Sn	27.0 h	50	71	51	80	0	0	•1	0	1
122Sn	STABLE	50	72	51	80	0	0	•1	0	1
123Sn	129.2 d	50	73	51	80	0	0	•1	•1	2
124Sn	>100•10é a	50	74	51	80	0	0	•1	0	1

125Sn	9.6 d	50	75	51	80	0	0	•1	•1	2
126Sn	2.3•10 a	50	76	51	80	0	0	•1	•1	2
127Sn	2.1 h	50	77	51	80	0	0	•1	•1	2
128Sn	59.0 min	50	78	51	80	0	0	•1	•1	2
129Sn	2.2 min	50	79	51	80	0	0	•1	•2	3
130Sn	3.7 min	50	80	51	80	0	0	•2	•2	4
131Sn	56.0 s	50	81	51	80	0	0	•2	•3	5
132Sn	39.7 s	50	82	51	80	0	0	•2	•3	5
133Sn	1.4 s	50	83	51	80	0	0	•2	•3	5
134Sn	1.1 s	50	84	51	80	0	0	•2	•3	5
135Sn	530.0 ms	50	85	51	80	0	0	•2	•4	6
136Sn	0.3 s	50	86	51	80	0	0	•2	•3	5
137Sn	190.0 ms	50	87	51	80	0	0	•2	•4	6

The average value for the Abs modifier for all isotopes of Tin is 51 and for the Hat modifier is 80. These figures are then used for all values of Abs and Hat and the score is a sum of the absolute differences.

Figure 1: Plot of Score for Tin



Using this scoring method has the advantage of being able to make a prediction on all of the isotopes and so does not require the "orderly clean-up" method used in Table 5.

Summary

The Block system produces the following results:

- Actual stable isotopes between Lithium and Calcium: 39 out of 365 [4];

- When using the Block method with protons using a prime number series and neutrons using a binary power series, the isotopes predicted as stable between Lithium and Calcium is 160 out of 365;

- When using the Block method with protons using a prime number series, neutrons using a binary power series and introducing an Abs modifier using the Fibonacci series, the isotopes predicted as stable between Lithium and Calcium is 71 out of 365;

- Combinations of modifiers can be used to show regions of stability and it may be possible to find a combination of modifiers that offer an exact prediction of stable isotopes;

- Isotopes with odd Z numbers between Oxygen and Lead that are built using Block A are not be stable.

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